

STRENGTH STRAND CONSTRUCTION FOR A
LONGITUDINAL SECTION OF A CABLE

TO ALL WHOM IT MAY CONCERN:

BE IT KNOWN THAT (1) CHARLES D. SPELLMAN, (2) WALTER J. RODERICK and (3) DONALD C. PORTOFEE, employees of the United States Government, citizens of the United States of America, and residents of (1) Rocky Hill, County of Middlesex, State of Connecticut, (2) Mystic, County of New London, State of Connecticut and (3) Westerly, County of Washington, State of Rhode Island, have invented certain new and useful improvements entitled as set forth above of which the following is a specification:

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3 STRENGTH STRAND CONSTRUCTION FOR A
4 LONGITUDINAL SECTION OF A CABLE

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6 STATEMENT OF GOVERNMENT INTEREST

7 The invention described herein may be manufactured and used
8 by or for the Government of the United States of America for
9 governmental purposes without payment of any royalties thereon or
10 therefor.

11

12 CROSS REFERENCE TO RELATED PATENT APPLICATION

13 This application is related to a co-patent application
14 (Attorney Docket No. 76589) entitled OUTER CASING STRUCTURE AND
15 FABRICATION METHOD FOR CABLE SECTIONS AND NAVY BUOYANT ANTENNAS,
16 filed on an even date herewith. This co-pending application is
17 hereby incorporated herein in its entirety.

18

19 BACKGROUND OF THE INVENTION

20 (1) Field of the Invention

21 The present invention relates to a novel apparatus and
22 method for providing tensile strength to longitudinal sections of
23 cables, including cables in which a linear energy transmission
24 medium has a surrounding arrangement of a damage resistant outer
25 sheath with emollient liquid between the sheath and the
26 transmission medium. It also relates to such providing tensile
27 strength to forms of cable section assemblies having a layer of

1 flexible molded material between the damage resistant sheath and
2 the central core structure containing the transmission medium.
3 An example of the latter type of cable section assembly is
4 disclosed in U.S. Patent No. 6,426,464, issued 30 July 2002, and
5 especially therein in a discussion of a best mode of that
6 invention for applications of that invention in which the cable
7 section assemblies are used in environments in which they are
8 extremely stressed (especially see the description therein at
9 column 12, line 65 through column 18, line 4). This U.S. Patent
10 No. 6,426,464 is hereby incorporated herein in its entirety. An
11 aspect of the invention is also of special utility in providing
12 tensile strength to cable section assemblies for microwave
13 coaxial lines.

14 (2) Description of the Prior Art

15 Submarines must be able to send and receive messages. Radio
16 reception from a submerged submarine is maintained through a
17 buoyant cable antenna ("BCA") which comprises an antenna line
18 train of components including at least at the trailing end
19 thereof a detachably connected longitudinal sectional component.
20 The BCA rises above the submarine and floats and streams at or
21 near the ocean surface. When not in use, the BCA is coiled
22 around a small diameter spool in the submarine, requiring
23 considerable flexibility. When deployed from the submarine, the
24 BCA and its components require a demanding structure due to the
25 substantial stress placed on the BCA. For example, the BCA is
26 subjected to severe mechanical shocks when towed in high sea
27 conditions, e.g., the BCA must rise from various depths and may

1 be subjected to waves of up to 35 feet at the ocean surface.
2 Thus, tensile strength is critical to the BCA structure.

3 Prior art BCA cable section assemblies elements are known
4 wherein the tensile strength was augmented by the provision at
5 their respective ends of cable-end grips of the type affixing to
6 core structures of the assembly by open-mesh-sleeves which
7 tightened their constriction on the core structure by Chinese-
8 finger-toy like tightening of the mesh sleeve around a grip
9 foundation sleeve molded on the core structure. Also a prior
10 attempt was made to increase the tensile strength and flexing
11 damage resistance characteristics of BCA cable section assemblies
12 was by potting the length of core structure in cured flexible
13 polyurethane, which is moldingly bonded to the grip foundation
14 gripped by the open-mesh-sleeves of the cable-end gripping
15 device. However, the prior attempt using this approach did not
16 provide a significantly improvement over the tensile strength and
17 flexing damage avoidance capabilities provided by the grip
18 sleeves and grip foundation alone.

19 Accordingly, there is an unsatisfied need for a cable
20 section assembly of a BCA having an imbedded coaxial cable which
21 has higher tensile strength and flexing damage resistance
22 characteristics than heretofore available by application of the
23 foregoing known prior art, and attempted approach of of
24 improvement, of insertion of a moldingly bonded grip foundation
25 into an open-mesh-sleeve type cable end grip.

1 There are additional prior art devices relating to various
2 types of cable assemblies or reinforcing members which do not
3 involve gripping by open-mesh-sleeves such as disclosed in U.S.
4 Patent Nos. 2,352,391; 4,463,358; 4,491,939; 4,749,420 and
5 5,057,092. Thus, for example, U.S. Patent Nos. 4,463,358 and
6 4,749,420 generally disclose basic buoyant cable antennas.
7 Additionally, U.S. Patent Nos. 2,352,391, 5,057,093 and 4,634,804
8 generally disclose the use of spaced elongated strengthening
9 members. U.S. Patent No. 4,491,939 generally discloses a cable
10 using a Kevlar® member.

11

12 SUMMARY OF THE INVENTION

13 It is a primary object of the invention to provide an
14 apparatus and method which provides higher tensile strength
15 characteristics than have heretofore been available in prior art
16 forms of structure of buoyant cable antenna (BCA) cable section
17 assemblies.

18 It is a further primary object of the invention to provide
19 an apparatus and method for providing high tensile strength
20 characteristics to a BCA cable section assembly which contains a
21 span of coaxial cable, one or more wire conductors, wire cable, a
22 fiber optic cable, other forms of linearly extending energy
23 transmission media, or electronic components serially distributed
24 along its length which are interleaved
25 between shorter spans of the coaxial cable.

26 It is another object of the invention to provide an
27 apparatus and method for providing tensile strength to a BCA

1 cable section assembly in a way which enables the component to be
2 readily designed to be of a selected length, which in turn
3 enables designing high tensile strength BCA cable section
4 assemblies to selectively match the length of an existing tubular
5 jackets for BCA's.

6 The invention is directed to strengthening an assembly which
7 includes a span of coaxial cable or other forms of energy
8 transmissive media, and which in one illustrative embodiment is
9 employed as buoyant antenna cable (BCA) cable section assembly.
10 In accordance with the invention, multiple longitudinal non-
11 metallic high tensile strength strands, which are integrated into
12 the span assembly by a specific construction and arrangement,
13 provide increased tensile strength to the span assembly. The
14 preferred material for the longitudinal strengthening strands is
15 Kevlar®, an aromatic polyamide fiber manufactured and sold by
16 E.I. DuPont de Nemours Company, which exhibits a high breaking
17 strength in the longitudinal direction. Specifically, axially
18 extending marginal end portions of the span of coaxial cable are
19 placed into a conventional two-part cable encasement producing
20 mold, into which is introduced a polyurethane forming polymer
21 composition which is cured at room temperature to form a grip
22 foundation molded and bonded to the cable around the marginal end
23 portion. In individual molding processes such grip foundation
24 are formed at each end of the span.

25 Each grip foundation has formed in its outer surface a set
26 of at least three longitudinal grooves. Upon curing and removal
27 from the mold, pairs of open-mesh-sleeve type cable-end grips,

1 are slid over the axial end sections of the cable potted in the
2 polymer grip casing. A corresponding set of at least three
3 longitudinal Kevlar strands of the same length as the cable span
4 are laid next to the cable spans and have their end portions
5 interlaced in and out of adjacent openings in the open-mesh-
6 sleeve of the cable-end grip device a significant number of
7 times, each strand being interlaced along a respective groove in
8 the grip foundations. The grooves in the grip foundation provide
9 room for the Kevlar strands to be pass there through in the
10 course of being interlaced through the mesh. The strands at each
11 end of the set are gathered and tied to an intersection of mesh
12 strands of the sleeve by a self-seizing knot at a position near
13 the axially outer end of the open-mesh-sleeve. The tail ends of
14 the strands beyond the knot are trimmed and tucked under the mesh
15 and secured in place, e.g., by epoxy glue, in order that the ends
16 do not protrude from the cylindrical envelope dimension of the
17 cable section assembly.

18

19 BRIEF DESCRIPTION OF THE DRAWINGS

20 A more complete understanding of the invention and many of
21 the attendant advantages thereto will be readily appreciated as
22 the same becomes better understood by reference to the following
23 detailed description when considered in conjunction with the
24 accompanying drawings wherein:

25 FIG. 1 is a mechanical schematic, depicted in the fashion of
26 a side elevation, of a microwave coaxial line cable section
27 assembly representative of apparatus in accordance with the

1 invention (only the portion of the span of strength strands being
2 shown for clarity);

3 FIG. 2 is a side elevation of one end of an interim
4 manufacturing step subassembly of the cable section assembly of
5 FIG. 1 (the other end being bilaterally symmetrical thereto) at a
6 stage of fabrication before the ends of the strength strands are
7 knotted, with details of grooves and interweaving of strength
8 strands and mesh being omitted for clarity;

9 FIG. 3 is an enlarged view of a portion of FIG. 2 showing
10 the interlacing of strength strands and the open-mesh-sleeve and
11 showing presence of a groove in the grip foundation underlying
12 the mesh;

13 FIG. 4 is a view like FIG. 2, but at a stage of fabrication
14 of the interim manufacturing step subassembly in which the
15 marginal end portions of the strength strands are bundle together
16 and the excess lengths of the strands are trimmed, with the
17 details of longitudinal grooves on the grip foundation, and the
18 details of the knot binding the bundle of marginal end portions
19 of the strength strands with the mesh strands of an open-mesh-
20 sleeve omitted for clarity;

21 FIG. 5 is a diagrammatic view representing an enlargement of
22 FIG. 4, which illustrates a suitable self-seizing knot for
23 binding the strands and two individual strands of an open-mesh-
24 sleeve; and

25 FIG. 6 is a section taken along section line 6-6, FIG. 3,
26 but with the mesh omitted for clarity.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Reference is now made to the drawings and more particularly to FIGS. 1-4 which depict an illustrative embodiment of the apparatus of the present invention. Referring now more particularly to FIG. 1, this apparatus is a microwave coaxial line cable section assembly 10, which includes the microwave coaxial line 11, sheath 11a (shown by phantom lines) which is for protection against damage to line 11 and for containing an emollient liquid 11b (that serves as a damping medium reduces the magnitude of concussion shock to the assemble which transmitted to line 11). FIGS. 2-4 are directed to an interim manufacturing step subassembly 10a of cable section assembly 10. An application of the embodiment of FIGS. 1-4 involving vulnerability to damage by small diameter capstan mechanisms and by potential high magnitude of shock in heavy sea states is disclosed in the hereinabove identified and incorporated by reference U.S. Patent No. 6,426,464. Therein cable section assembly may be used as a component of the r.f. lead-in and tow cable section (designated 108a, FIG. 2, therein) of a buoyant cable antenna (BCA) line (designated 104 therein) towed behind a submarine. It is to be understood that the concepts and teachings of the present invention also have applicability to embodiments like that shown in the hereinabove identifies copending application "Outer Casing Structure and Fabrication Method for Cable Sections and Navy Buoyant Antennas" wherein the annular space between an outer casing (designated 14 therein) and a energy transmission central core structure (designated as a

1 conduit 20 and runs of elective wires 22 therein) is filled with
2 a molded plastic element (designated 24 therein). The concepts
3 and teachings of the present invention further have applicability
4 to embodiments having molded plastic elements between the outer
5 sheath and a central energy transmission structure wherein the
6 central structure houses plastic encapsulated circuit boards,
7 such as the embodiments disclosed in the hereinabove identified
8 U.S. Patent Application No.6,426,464 wherein the annular space
9 between the outer sheath (designated 40 therein) and the
10 protective tube (designated 14 therein) containing runs of
11 electronic hook-up media (designated 12 therein) and between the
12 sheath and the electronic circuit boards (designated 18 therein)
13 contains plastic molded parts (designated 16 and 20 therein).
14 (The application of this invention to the latter embodiment
15 disclosed in U.S. Patent No. 6,426,464 will be discussed of
16 drawings later herein.) A typical length of a BCA longitudinal
17 sectional component of a BCA line is of the order of ten feet.
18 In operational use a BCA sectional component can be exposed to
19 enormous tensile and flexional strains and stresses with
20 considerable shock or concussion effects. For example, The sea
21 surface whereat the BCA sectional component floats and streams at
22 the speed of the towing submarine may can attain sea states
23 having 35 foot wave.

24 Cable span assembly 10 serves a two-fold function namely (i)
25 provision of the mechanical structural support needed to
26 withstand the aforesaid stresses and (ii) provision of the

1 instrumentalities for mechanical and electrical connection with
2 an adjoining portion.

3 It is to be understood that as one of the last steps of
4 manufacture of a BCA longitudinal sectional component, the cable
5 span assembly 10 is fitted into a suitable jacket 11a (shown by
6 phantom lines) which serve to: (i) protect cable span assembly 10
7 from abrasion, (ii) seal off cable span assembly 10 from
8 seawater, and (iii) where buoyancy is desired provide a housing
9 which forms space to contain buoyant material.

10 In accordance with the present invention a set of at least
11 three high tensile strength and high breaking point strength
12 strands 12 (which FIGS. 1-3 and 6 show without the complication
13 of knotting; and which FIGS. 4 and 5 show including the knotting)
14 provide cable section assembly 10 with the tensile strength and
15 resistance to damage by flexing needed to withstand the above
16 discussed large scale stresses and strains. The mechanical
17 construction and arrangement by which strength strands 12 provide
18 this tensile strength and resistance to flexure damage will be
19 understood as this description proceeds.

20 It is to be understood that although the foregoing
21 illustrative embodiment discloses microwave coaxial cable as the
22 object of the mechanical structure support by cable section
23 assembly 10, the concept of the present invention also extends to
24 use of the assembly as such support linearly extending energy
25 transmission medium generally including conductor wires, wire
26 cables, and fiber optic cables.

1 A preferred material to be employed as the high tensile
2 strength, high breaking point set of strands 12 is an aromatic
3 polyamide fiber widely commercial available and often identified
4 by tradename Kelvar® of E.I. DuPont de Nemours Company. Kevlar®
5 is the preferred material because it exhibits a high breaking
6 strength in the longitudinal direction. Other aromatic polyamide
7 fibers having tensile strength characteristics similar to Kevlar®
8 may also be used in accordance with the invention.

9 Referring now collectively to FIGS. 1, 2, 3 and 6, in the
10 construction of span assembly 10, an axially extending grip
11 foundation 14 is molded and bonded to coaxial cable 11. It is to
12 be understood that a minor image of the constructions of FIGS. 2,
13 3 and 4 are present at the opposite side of assembly 10.
14 Illustrative of cable 11 is the RG-178, flexible coaxial cable
15 for transmitting microwave signals manufactured by Times
16 Microwave Systems. Referring to FIG. 6 cable 11 includes a
17 moldingly bonded concentric arrangement of an central linear
18 member 11a, an intermediate layer portion 11b, and an outer layer
19 11c at least the latter of which has an affinity for moldingly
20 bonding with thermo-setting molding compounds. The process of
21 molding and bonding grip foundation 14 to cable line 11 may
22 employ a 2-part mold adapted to receive a span of the cable and
23 to mold a grip foundation encasement around an axial section
24 thereof. At each of the opposite end of cable line 11 an axially
25 extending section of the line proximate to the respective ends of
26 the line is placed in the mold, and the mold is filled with a
27 thermo-setting polymer composition which is curable at room

1 temperature. Stated another way, the selected axial section of
2 the coaxial cable is potted in the polyurethane polymer grip
3 foundation 14. A preferred polymer is TC-512, a polyurethane
4 curing polymer composition manufactured and sold by BJB
5 Enterprises of Garden Grove, California. When the polyurethane
6 is cured, the coaxial cable line, or other form of transmission
7 media 11 and the grip foundation 14 will have formed an
8 integrably molded cable and grip foundation subassembly 17, FIG.
9 6, which has a length co-extensive with the open-mesh-sleeve of a
10 cable-end grip device (cable-end-grip device assembly 20 and its
11 component mesh-sleeve 24 shown in FIGS. 1,2 and 4 will be
12 introduced and discussed in detail later herein). Subassembly 17
13 is then removed from the mold. Other thermo-setting polymers
14 which may be employed include polysulfides and RTV silicones. In
15 a preferred embodiment, grip foundation 14 has formed therein a
16 set of at least three longitudinal grooves 18 (best shown in FIG.
17 6) of a number corresponding to the number of strength strands in
18 strength strands set 12. For the embodiment of a cable section
19 assembly 10 containing microwave coaxial cable line wherein the
20 outside diameter, and of an outside diameter of 0.65 inches this
21 the number of grooves 18 on grip foundation 14 is three (3).
22 However, additional grooves may be utilized to enable utilizing
23 additional strength strands 12 and increasing the tensile
24 strength of cable span assembly 10. Grooves 18 are preferably
25 formed in the course of molding. In planes perpendicular to the
26 axis of the coaxial cable line 11, groove 18 are equiangularly
27 radially spaced and the grooves in the grip foundation at

1 opposite ends of interim manufacturing step subassembly 10a are
2 in angular registry with one another about the cable axis. The
3 grooves are of a depth to provide recessed spaces to receive the
4 longitudinal strength strands 12. This is best seen in the
5 cross-section of subassembly 17 in FIG. 6.

6 At each end of subassembly 10a there is a cable-end grip
7 device assembly 20, which comprises (i) an axially outwardly
8 disposed mechanical and electrical coupling subassembly 22, and
9 (ii) an axially inwardly disposed open-mesh-sleeve 24. The
10 aspect of subassembly 22's mechanical attachment to coaxial cable
11 line 11, and the aspect of electrical coupling performed by
12 subassembly 22 are conventional and form no part of the
13 invention. The open-mesh-sleeve component 24 of grip device
14 assembly is also conventional. However, as will become apparent
15 as this description proceeds its structure and the structural
16 relationship between it and other elements of interim
17 manufacturing step subassembly 10a is an important aspect of the
18 present invention. In attaching each grip assembly 20 at the
19 ends of subassembly 10a, the open-mesh-sleeve component 22 is
20 slid over and receives the outer surface (sometimes hereinafter
21 and in the appended claims called the "grip foundation surface")
22 14 within cylindrical interior of the mesh with a fit that any
23 sliding motion in the direction of withdrawing the grip
24 foundation 14 causes considerable sliding friction. Such sliding
25 friction in turn causes the "Chinese-finger-toy" phenomenon of
26 causing radial constriction of the open-mesh-sleeve, in turn

1 increasing the gripping force which assembly 20 exerts on grip
2 foundation 14.

3 As best shown in FIG. 3 open-mesh-sleeve 24 is of the
4 conventional type in which first and second pluralities of mesh
5 forming strands are helically wound in opposite helical
6 directions of winding in a construction known as a braided open-
7 mesh-sleeve (i.e., the mesh strands alternately pass above and
8 below successive mesh strands wound in the opposite direction).
9 Note that in the embodiment of FIG. 3 the number of strands in
10 each of the first and second pluralities of strands wound in
11 respective opposite directions of helical winding is three (3).

12 As mentioned earlier herein, high tensile strength and high
13 breaking point strength strands 12 augment the tensile strength
14 and flexure damage resistance characteristics of interim
15 manufacturing step subassembly 10a. As particularly shown in FIG.
16 6 in conjunction with FIGS. 2 and 3, the number of strands of the
17 set, which corresponds to the number of axially extending grooves
18 18 in grip foundations 14 are laid along the respective grooves
19 18 at each end of assembly 10. In the embodiment of FIGS. 2-4
20 there are three strands to a set. The spans of the individual
21 strands extend between the grip foundation 14 generally
22 coextensively with the total length of coaxial cable line 11.
23 The end portions of the strands 12 include enough excess strand
24 material to permit getting a purchase hold on the strand for
25 purposes of the processes of knotting and making the strands
26 taut, to be described later. Proximate to each end of each
27 strength strand 12 is an axially extending portion that lies next

1 to a groove 18 in the grip foundation 14. Except for knotting at
2 its axially out end, this portion of each strand is interlaced in
3 and out of successive openings in the associated open-mesh-
4 sleeve. As best shown in FIG. 3 the interlacing taking place
5 where mesh strands being wound in opposite helical directions
6 cross. The grooves 18 provide enough space underneath the open-
7 mesh-sleeves 24 to accommodate the interlacing.

8 Referring now to FIGS. 2 and 4, as mentioned the interlacing
9 of strength strands in and out of mesh sleeve 24's openings
10 terminates short of the axially outwardly end of mesh sleeve 24
11 to enable the knotting and strength strand tensioning processes
12 hereinafter described. In an illustrative embodiment of a cable
13 section assembly 10 for the aforesaid RG-178 coaxial cable line
14 interlacing is terminated approximately two inches from the
15 axially outer end of open-mesh-sleeve 24, and the strength
16 strands are interlaced in and out of twelve openings in the mesh
17 sleeve, i.e., six cycles of interlacing took place.

18 At each end of a subassembly 10a the outer ends of the
19 strands beyond termination of the interlacing are gathered and
20 together knotted into a modified Diamond form self seizing knot
21 25, FIG. 5, at a location in the open-mesh-sleeve where two mesh
22 strands winding in opposite directions of helical winding cross.

23 It is to be appreciated that the modified Diamond self-seizing
24 knot 25 conjointly binds together the strands of set 12, and two
25 mesh strands respectively winding in opposite direction of
26 helical winding. As an alternative to the modified Diamond knot,
27 any of a number of other of known self-seizing process knotting

1 process which can effect such conjunctive binding of strands.
2 Using any suitable jig arrangement, or manually by two or more
3 craftsmen working as a team, the coextensive spans of coaxial
4 line 11 and the sets of strength strands are simultaneously drawn
5 into taut conditions during the knotting process. Note that the
6 ends of coaxial cable line 11 are made fast to the grip devices
7 at opposite ends of cable section assembly 10 by action of the
8 open-mesh-sleeve upon the grip foundation. The excess lengths of
9 strength strands 12 are then trimmed, tucked under a nearby
10 strand of open-mesh-sleeve 24, and secured in place, such as by
11 epoxy glue. This is done in order that they do not protrude from
12 subassembly 10a's dimensional envelope requirements for fitting
13 in sheath 13.

14 After intermediate manufacturing step subassembly 10a is
15 fabricated, the completion of assembly of cable section assembly
16 10 is performed. Subassembly 10a is fitted within sheath 10a
17 (phantom lines, FIG. 1), using any of a number of known
18 techniques and jig arrangements. A sealing relationship between
19 the marginal end portions of sheath 13 and the axially outwardly
20 disposed mechanical and electrical coupling subassemblies 22,
21 FIG. 1 of the cable-end grip devices 20 established is performed
22 to seal against seawater entering the sheath, or to otherwise
23 satisfy other requirements for hermetic sealing. This is done
24 using any of a number of known constructions and techniques.
25 Finally, the generally annularly cross-sectioned space along the
26 length of the span of coaxial line 11 is filled with any suitably

1 emollient liquid, and the penetrations made in the sheath in the
2 performance of the filling are sealed.

3 At the time the ends of the sets of strength strands 12 were
4 knotted to the open-mesh-sleeves 24, the generally coextensive
5 spans of the strength strands 12 and the coaxial cable line 11
6 were simultaneously in taut conditions. The self-siezing
7 modified Diamond knots make fast the ends of the set of strands
8 12, to the grip devices 20 at opposite end of assembly 10, FIG.
9 1. As noted the ends of cable line 11 are also made fast to the
10 grip devices by action of open-mesh-sleeves 24 upon grip
11 foundations 14. Therefore, in cable section assembly 30, FIG. 1,
12 the two gripping devices 20 upon tying knots 25 the assembly's
13 opposite ends are constrained to a predetermined maximum distance
14 of separation determined by the length of the spans of cable line
15 11 and the length of span of strands 12 between. This is fixed
16 regardless of the tension across assembly 10 or forces of flexing
17 upon assembly 10. Further, because axial sections of the
18 strength strand laying adjacent to grooves 18 in grip foundations
19 14 are interlaced through openings in the open-mesh-sleeve 24, an
20 increase in tensions across all the strands together, or across
21 only one or tow of the strands (in the case of flexing) will
22 cause open-mesh-sleeve 24 to constrict in the manner of a
23 Chinese-finger-toy, increasing the gripping actions that make
24 fast the ends of coaxial cable line 11 to the cable end gripping
25 devices 20. This combination of effects of the strength strand
26 construction and arrangement in accordance with the present
27 invention provide a capability of cable section assembly 10 to

1 cope with large surges in tensile stress, and a capability to
2 cope with effects of repeated flexing during reeling of the cable
3 section on small diametered reels.

4 The invention has been above described in connection with an
5 embodiment of BCA longitudinal sectional component shown in FIG.
6 1 having a continuous coaxial cable extending between the grip
7 assemblies 20 at the ends of the sectional component, with the
8 void space between the jacket 11a and the cable span core
9 assembly 10 filled with emollient liquid.

10 However, it is to be understood that the concept of the
11 invention extends to other embodiment of BCA sectional components
12 wherein the spaces between the jacket and a cable span core
13 assembly contain glass microballoon filled polyurethane buoyant
14 material (not shown herein), and the core assembly comprises a
15 plurality of sections of coaxial cable (not shown herein) having
16 interleaved therebetween electronic component units (not shown
17 herein). The microballoon filled polyurethane material is
18 relatively soft. A preferred microballoon filled polyurethane
19 material to occupy the spaces between the jacket and the cable
20 span core assembly is disclosed in said U.S. Patent 5,606,329.
21 Each of the electronic component units comprises an electronic
22 circuit board (not shown herein) embedded on a polyurethane
23 encapsulate (not shown herein) which is harder than the buoyant
24 polyurethane material. An example of this type of encapsulant
25 for of BCA sectional component is disclosed in the hereinabove
26 identified and incorporated by reference U.S. Patent 6,426,424.
27 The above mentioned described (i) buoyant, filled polyurethane

1 material (designated 16 therein), (ii) sections of coaxial cable
2 (designated 12a, 12b, etc. therein), (iii) electronic circuit
3 boards (designated 18a, 18b, etc. therein), and (iv) harder
4 polyurethane encapsulate (designated 20a, 20b therein) may be
5 seen in figures 3, 4 and 4a of U.S. 6,426,464, respectively. A
6 further structural feature which can be seen in figure 4 of U.S.
7 6,426,464 is that the plural sections of coaxial cable are each
8 encased in a flexible tubular conduit (designated 14 therein),
9 which at each of its ends is moldingly bonded with the harder
10 polyurethane encapsulate (designated 120, therein) of the
11 adjacent electronic component unit or with an adjacent grip
12 foundation (not shown in U.S. 6,426,464) which is also of such
13 harder polyurethane material.

14 The following described modifications to the structure
15 disclosed in U.S. Patent 6,426,464 constitutes the best mode
16 which the inventors contemplate in connection with a BCA
17 longitudinal sectional component in which void spaces between the
18 jacket and the cable span assembly are occupied with a soft,
19 buoyant microballoon containing polyurethane type material
20 instead of the emollient liquid. Three or more strength strands
21 as described hereinabove in connection with the embodiment of
22 FIG. 1 of the present invention, extend between the grip
23 assemblies at the ends of the sectional component. However,
24 instead of extending in the void space between the grip
25 foundations they pass through flexible tubular conduits encasing
26 the coaxial cable sections, and pass through and are moldingly
27 embedded in a harder polyurethane encapsulate of the electronic

1 component units interleaved between coaxial cable sections. In
2 this best mode, the substrate upon which each grip foundation is
3 molded as an extension of the outermost of these tubular conduits
4 at the opposite ends of cable span assembly designated 110
5 therein. The strands are located in sectors of a transverse
6 reference plane through the encapsulate where they will not
7 interfere with the circuit board which is also embedded in each
8 electronic component unit. In the tubular conduits adjacent to
9 the grip subassemblies (designated 17 therein) at the ends of the
10 sectional component, and more particularly at axial locations in
11 these outermost tubular conduits adjacent to where the grip
12 foundation starts, the ends of the strength strands are turned
13 radially outward and brought out of the tubular conduit through
14 radial openings in the wall of the tubular conduit. Outside the
15 tubular conduit, the radially extending expanses of the strands
16 are drawn taut and lie essentially in abutting relation to the
17 inner annular end face of each grip foundation (described, but
18 not shown in U.S. Patent No. 6,426,464). At the circular corner
19 edge between the annular end face of a grip foundation and the
20 circumferential surface of the foundation, the strength strands
21 are turned over the corner and extend axially outward in a groove
22 as described in connection with FIG. 6 herein. These axially
23 extending expanses are interlaced in the opens spaces of the
24 open-mesh-sleeve, and ultimately gathered and bound together and
25 with helically counter-rotating sleeve strands as described in
26 connection with FIGS. 2-5 herein. The advantage to confining the
27 strength strands within the tubular conduits and bringing them

1 out of the conduit in taut abutting relationship to the annular
2 end face and the tautly turning them for interlacing in the
3 longitudinal direction and attachment to the open-mesh-sleeve is
4 that rips and tears in the soft microballoon containing material
5 in annular spaces adjoining the end faces of the grip foundation
6 under stressing and straining of the strength strands is avoided.
7 Similarly, the advantage of passing the strength strands through
8 the tubular conduits and moldingly potting them within the harder
9 encapsulate of the electronic units between the coaxial cable
10 sections is that tears and rips in the softer buoyant
11 microballoon material in annular spaces between the electronic
12 units under stressing and straining of the strength strands is
13 avoided. For additional detail and information see column 12,
14 line 65 through column 18, line 4, of the hereinabove referenced
15 and incorporated by referenced U.S. Patent No. 6,426,464.

16 It is to be understood that the form which the object of
17 cable span assembly 10's support takes has little bearing on
18 broader aspects of the invention. Instead it is to be
19 appreciated that cable span assembly 10 can provide tensile and
20 flexional strength support for any flexible linearly extending
21 utilization object.

22 Obviously, many other modification and variations of the
23 present invention may become apparent in light of the above
24 teaching. It is therefore to understood that within the scope of
25 the following claims, the invention may be practiced otherwise
26 than as specifically described.